

**GEOTECHNICAL AND GEO-ENVIRONMENTAL  
SITE INVESTIGATION**

**BONDFIELD COURT, WOMBWELL**

**FOR**

**STRATEGIC TEAM GROUP**

**ISSUE 1**



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# GEOTECHNICAL AND GEO-ENVIRONMENTAL SITE INVESTIGATION

BONDFIELD COURT, WOMBWELL

FOR

STRATEGIC TEAM GROUP

ISSUE 1

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## 1.0 EXECUTIVE SUMMARY

1. The approximately 1.43 hectare site is located to the south of Bondfield Close in Wombwell. The majority of the site is covered with trees and bushes, with occasional footpaths and clearings. An access road is present in the west of the site which leads from Bondfield Close to King's Oak Primary Learning Centre immediately beyond the southern site boundary. An earth bund up to around 2 m high is present in the south east of the site.
2. The solid geology below the site comprise the Oaks Rock sandstone of the Middle Coal Measures. No superficial deposits or fault lines are shown to underlie the site.
3. Topsoil/made ground or made ground was encountered below the majority of site to depths of between 0.2 and 2.0 m, and typically no greater than 1.3 m. The natural ground below the site typically comprises weathered sandstone. Clay tending towards mudstone was encountered within one trial pit in the south west of the site at a depth of 1.8 m to at least 2.4 m, whilst thin bands of clay were locally encountered with a thickness of up to 500 mm within a further two trial pits.
4. A slight groundwater ingress was recorded at the surface of the clay at the base of TP115. Slightly damp strata were encountered between 1.6 and 2.5 m bgl within one pit in the south west of the site. No other groundwater ingresses were noted.
5. An embankment up to approximately 2 m high is present adjacent to the western site boundary. Releveling of this embankment is expected to be required prior to development, and retaining should be allowed for.
6. Traditional strip or trench fill foundations taken into the weathered sandstone at a minimum depth of 750 mm are considered to be suitable for the site. Where greater thicknesses of made ground are present or where ground levels are raised, traditional trench fill foundations may be required.
7. Where cohesive ground is found, a minimum depth of 900 mm should be applied. Foundations within clay soils will need to be designed in accordance with the NHBC Standards, Chapter 4.2, however tree influence is expected to be minimal as the natural ground was predominantly granular in nature.
8. The weathered sandstone became difficult to excavate within a number of pits at depths of between 1.3 and 2.7 m bgl. The stability of trenches may be poor within sandy soils or within made ground. Larger objects including reinforced concrete, old rebar and old concrete beams were encountered within two trial pits in the north east of the site.

9. Infiltration testing has been carried out which indicates that soakaways drainage is considered to be viable for the site, although the lower infiltration rates recorded in the south west will need to be taken into account during design.
10. One sample of topsoil/made ground (TP121) recorded elevated concentrations of five PAHs and asbestos fragments/fibres. Any visible fragments of asbestos containing material should be removed by a specialist contractor. After removal of visible ACM, it is recommended that the topsoil/made ground around TP121 is tested further to confirm its suitability. Due to the extraneous material content, the remaining topsoil may also require screening but should be suitable for re-use, subject to regulatory approval.
11. The ashy made ground found below the south east of the site recorded elevated concentrations of metals and PAHs, and recorded calorific values of 10 and 15 MJ/kg, indicating the material is potentially combustible. The general made ground recorded elevated metals and PAHs, and possible asbestos sheet fragments although no fibres were recorded. Where made ground is to remain below gardens, a minimum 600 mm thick capping layer (including at least 100 mm clean topsoil) will be required. The capping thickness will need to be increased to 1 m where ashy made ground is present due to the potential for combustion.
12. No radon or ground gas precautions are required for the site.
13. DS-3 AC-4 sulphate precautions are required for sub-surface concrete in contact with the ashy made ground, and DS-2 AC-2 for the remaining made ground. DS-1 AC-2z sulphate precautions are required for concrete in contact with the natural ground only.
14. The conclusions made in this report are subject to agreement by the approving bodies, such as the Local Authority, and your warranty provider.

## **2.0 INTRODUCTION**

### **2.1 Terms of Reference**

This report presents the findings of a Geotechnical and Geo-environmental Site Investigation carried out by Eastwood & Partners (Consulting Engineers) Ltd on the behalf of Strategic Team Group. Any other parties using the information in this report do so at their own risk and any duty of care is excluded.

### **2.2 Context**

Eastwood & Partners are aware of two site investigations previously undertaken at the site:

- CoDa Structures (Consulting Civil and Structural Engineers) produced a Phase 1 and 2 Engineering and Environmental Assessment. This report is dated March 2007 and referenced 6062; and
- Eastwood & Partners have previously produced a Geotechnical and Geo-Environmental Site Investigation. This report is referenced 40547-001 and dated November 2016.

### **2.3 Aims and Objectives**

The aims and objectives of this investigation were as follows:

- Assimilate Desk Study data to derive an outline conceptual model identifying potential contaminants, pathways and receptors, as well as possible linkages between these;
- Obtain information enabling refinement and subsequent testing of the conceptual model;
- Carry out a tiered risk assessment to establish the likely risks to future receptors, involving the use of generic assessment criteria and where unacceptable risks are identified, site specific assessment criteria within a detailed quantitative risk assessment;
- Identify feasible remediation options if unacceptable risks are highlighted;
- Develop an appropriate remediation strategy where remediation is required; and
- Detail the ground conditions and their geotechnical properties enabling outline foundation proposals to be made.

### **2.4 Scope of Investigation**

This document is split into two sections. These constitute the findings of the Desk Study and Phase 2 investigations, consecutively.

### **2.4.1 Desk Study**

The Desk Study involved a review of information extracted from published documentation as well as that obtained from the previous Desk Study report produced for the site. Information regarding the current and former land uses both on and surrounding the site, as well as the environmental sensitivity of the site location as determined by factors including geology, hydrogeology and hydrology have been examined.

Information analysed in this section of the report has been obtained from a variety of sources and included the following:

- A Landmark Envirocheck;
- A Coal Authority Mining Report;
- British Geological Survey maps; and
- The British Geological Survey website.

The results of the Desk Study were used to derive an outline conceptual model from which a preliminary risk assessment was made.

### **2.4.2 Phase 2**

This part of the investigation consisted of intrusive works and laboratory analysis. The findings were used to test the conceptual model and produce a final risk assessment. The intrusive works comprised trial pits to enable:

- Examination of the upper few metres of ground;
- In situ description of soils, enabling any localised lateral and vertical changes in soil conditions to be logged;
- Assessment of any contamination identified using visual and olfactory methods;
- Collection of soil samples for chemical testing; and
- Infiltration tests to be undertaken.

## **2.5 Limitations of Investigation**

This report is based on the assumption that the site will be developed with housing and that site levels will not alter significantly. If this is not the case, then the advice given in this report may not be appropriate.

Where assessments of site areas affected in particular ways are given, these are approximate. All information, comments and opinions given in this report are based on the ground conditions encountered during the site work, on the results of laboratory testing carried out as part of the investigation and information gained from a geological, historical and environmental desk study. However, there may be conditions at the site that have not been taken into account, such as unpredictable soil strata and water conditions between or below investigation points. It should be noted that groundwater levels vary due to seasonal or other effects, and may at times differ from those measured during the investigation.

This report considers the ground and groundwater and does not cover any buildings or their fabric, or the constituents of any existing hardstanding materials. Generally, testing has only been carried out for contaminants identified as potentially present with no assessment made of biological contamination. Risks to ecological receptors, such as bats, have not been considered.

## **3.0 THE SITE**

### **3.1 Description**

The approximately 1.43 hectare site is located to the south of Bondfield Close in Wombwell and is centred on grid reference 439570 402910.

The site was previously occupied by 'The Gables School' until its demolition around 2006 to 2007. The majority of the site is covered with trees and bushes, with occasional footpaths and clearings. An access road is present in the west of the site around 15 m from the site boundary. It runs from Bondfield Close to the north of the site to King's Oak Primary Learning Centre immediately beyond the southern site boundary. An earth bund up to around 2 m high is present in the south east of the site, along with localised macadam hardstanding from the previous development. Residential development is located to the north, east and west of the site.

The site is relatively level at around 72 to 74 m AOD apart from the earth bund in the south east of the site. An approximately 2 m high vegetated embankment is also present along much of the western site boundary and the road.

### **3.2 History**

Historical Ordnance Survey maps within the Envirocheck have been reviewed to assess the previous use of the site and surrounding area.

#### **3.2.1 The Site**

The earliest map reviewed, dated 1854-55, shows the site to comprise open fields.

By 1931, a football ground is shown to extend onto the southern half of the site from the south. It is surrounded on all sides by embankments, and an associated structure is shown to extend within the south west corner of the site. The northern half of the site is occupied by allotment gardens, including glasshouses.

The football ground is converted into a greyhound stadium by 1962.

The greyhound stadium is no longer shown by 1980. In the north of the site, the allotment gardens are no longer labelled, although the garden boundaries are still shown. By 1982, The Gables School is developed on the site. The main school building is present in the south of the site, with associated roads and assumed playgrounds around the school building, and an access road leading from Bondfield Close to the north of the site. The school was demolished between 2006 and 2018.

### **3.2.2 The Surrounding Area**

The earliest map shows the majority of the surrounding area to comprise open fields.

By 1892, a rectory is developed around 70 m to the north east of the site, whilst residential development is located from around 180 m to the north east of the site. Victoria Almshouses and Wombwell Cemetery are located around 70 m and 110 m to the north of the site respectively.

By 1930, the football ground which extends onto site from the south had been constructed. Allotment gardens and residential development are located to the south of the football ground, around 90 m and 140 m from the site respectively. Allotment gardens are also present to the east and west of the northern half of the site, and residential development is present to the north of the site.

Residential development is shown to have begun to the east of the site by 1938. The 1948 map shows this development to be completed, whilst another development has started to the west of the site. This development is shown to be completed on the 1956 map.

By 1976, a training centre is labelled adjacent to the north east of the site. The greyhound stadium (converted from the football ground by 1962) is no longer shown by 1980, and is replaced by Oakfield Junior School around 40 m to the south of the site.

The most recent historical map, dated 2018, shows Kings Oak Primary Learning Centre present immediately to the south of the site, whilst the training centre to the north has been replaced by housing.

### **3.3 Geology**

The geological map for the area, Sheet 283 NW (1:10,560) and the online British Geological Survey viewer show the site to overlie the Oaks Rock sandstone of the Middle Coal Measures.

No superficial deposits or fault lines are shown to underlie the site.

### **3.4 Hydrogeology**

The Envirocheck states that the solid geology below the site is classified as a Secondary A Aquifer. These are defined as permeable layers capable of supporting water supplies at a local rather than strategic level, and in some cases can form an important source of base flow to rivers.

The site is not located within a Groundwater Source Protection Zone.

The Envirocheck doesn't record any water abstractions within 1000 m of the site.

### **3.5 Hydrology**

The Envirocheck indicates the nearest surface water feature to be located 470 m to the north east of the site. This is expected to be a section of a disused canal.

### **3.6 Coal Mining**

The geological map, Sheet 283 NW, indicates the shallowest named coal seam below the site to be the Swinton Pottery coal, conjectured to outcrop approximately 370 m to the south west of the site.

A dip of around 4 degrees was recorded at the nearby Wombwell Main Colliery. Using this dip and taking into account topographic height difference between the site and the outcrop, the Swinton Pottery coal is expected to lie from around 25 m below the site.

The geological memoir records the Swinton Pottery Coal to be thin with dirt partings. The seam is not likely to have been worked. The clay seat-earth (around 0.3 to 0.6 m thick) below the coal was occasionally worked as pottery clay, mainly at Swinton Pottery located several kilometres south east of the site, where the coal was around 400 mm thick. The seam is probably thinner, or absent altogether, below the site given the progression to shale northwards across the area, according to the memoir. Even if workings are present, there is expected to be sufficient thickness of competent rock cover between the coal and the surface.

A Consultants Coal Mining Report has been obtained for the site. This records underground workings in 9 coal seams at depths of between 123 and 600 m, last worked in 1978. The shallowest recorded worked seam is the Furnace Coal, which has an extraction thickness of 0.86 m, and was last worked in 1955. It does not mention the presence of any worked shallow coal seams (i.e. at depths of less than 30 m), which backs up the evidence from the geological map that workings within the Swinton Pottery Coal may be absent beneath the site.

The Coal Authority has not received any claims related to coal mining subsidence within 50 m of the site since 1994. No mine entries are located within 100 m of the site boundary, although records may be incomplete, and there is no record of mine gas emission requiring action from the Coal Authority.

The site is within an area where a notice to withdraw support was given in 1983. Given the decline in the UK's coal mining industry, future coal mining is considered unlikely.

The site is therefore not considered to be at risk from the effects of shallow coal mining.

### **3.7 Ground Gas**

The Envirocheck states that no radon precautions are required for the site.

Historically, allotment gardens have previously been located across the northern half of the site, whilst a football ground and latterly a school have been located within the southern half of the site. Made ground is therefore expected to be encountered below these former developments but not a significant thickness.

According to the Envirocheck, there are no active or historical landfill sites and no potentially infilled land features located within 250 m of the site.

### **3.8 Pollution Incidents to Controlled Waters**

According to the Envirocheck, there are no pollution incidents to controlled waters within 250 m of the site.

### **3.9 Discharge Consents**

The Envirocheck does not record any discharge consents within 500 m of the site.

### **3.10 Flooding**

According to the Envirocheck, the site does not lie within a floodplain. The centre of the site is shown to be at low to medium risk of surface water flooding, whilst a section of the access road in the west of the site is shown to be at low to high risk.

The whole site is shown to have a limited potential for groundwater flooding to occur.

### **3.11 Soil Geochemistry**

The Envirocheck estimates the following concentrations of arsenic, cadmium, chromium, nickel and lead to be present in the natural soil below the site:

| Contaminant | Estimated Concentration (mg/kg) | Assessment Value (mg/kg) |
|-------------|---------------------------------|--------------------------|
| Arsenic     | 15 to 25                        | 37                       |
| Cadmium     | <1.8                            | 11                       |
| Chromium    | 60 to 90                        | 910                      |
| Lead        | <100                            | 200                      |
| Nickel      | 15 to 30                        | 180                      |

Concentrations of these contaminants are not expected to be elevated within the natural ground.

## 4.0 OUTLINE CONCEPTUAL MODEL

The site is being considered for development with residential properties with private gardens and associated areas of soft landscaping and hardstanding.

### 4.1 Potential Sources of Contamination

Historically, allotment gardens, a football ground and most recently a school have been present on the site. Any topsoil or made ground below the site present may contain elevated concentrations of heavy metals/metalloids, polycyclic aromatic hydrocarbons (PAHs), sulphates and asbestos fibres.

### 4.2 Ground Gas

No radon or ground gas protective measures are considered to be required.

### 4.3 Potential Pollutant Linkages

The table below details the possible sources and associated contaminants of concern, pathways and receptors, highlighted by the Desk Study as potentially present.

| Source                 | Potential Contaminants                             | Pathway                                                                   | Receptor                                                                                                            |
|------------------------|----------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Topsoil<br>Made ground | Heavy metals/metalloids<br>PAHs<br>Asbestos fibres | Ingestion<br>Inhalation<br>Direct contact<br>Migration through the ground | Site construction workers<br>Residents and future visitors to the site<br>Secondary A Aquifer<br>Water supply pipes |

## **5.0 PHASE 2 INVESTIGATION**

### **5.1 Site Works**

Eastwood & Partners visited site on 22 and 23 August 2018 and excavated twenty one trial pits, TP101 to TP121, to determine the underlying ground conditions. The trial pits reached depths of between 1.3 and 3.55 m below ground level (bgl).

Soakaway tests were carried out within seven of these pits, referenced SA1 to SA7.

Copies of the trial pit logs are presented in Appendix 3, and their positions are plotted on the Exploratory Hole Location Plan, drawing number 42937/001A, in Appendix 1.

### **5.2 Laboratory Testing**

One sample of natural clay/mudstone was dispatched for geotechnical testing at Professional Soils Laboratory. The geotechnical test results are presented in Appendix 4 and discussed further in Section 7.

Four samples of topsoil/made ground, eleven samples of made ground and four samples of natural ground were dispatched for chemical testing. Soil samples were taken in 500 g plastic tubs and 250 ml amber glass jars. All samples were analysed at Chemtest Limited, using MCERTs accredited methodologies where available. The chemical test results are presented in Appendix 5 and discussed further in Sections 8 and 9.

## **6.0 GROUND CONDITIONS**

### **6.1 Surface Covering**

The site is largely surfaced by vegetation comprising trees and bushes. No trial pits were excavated where dense vegetation is present. Where the trees and bushes are less dense, the site is typically surfaced by scrubby grass overlying topsoil/made ground or made ground. The topsoil/made ground was encountered within eight pits to a depth of up to 1 m, although typically extends to between 0.3 and 0.5 m bgl. It is generally present in the north and west of the site, and typically comprises brown gravelly clay or sand with gravel of sandstone and brick fragments with less frequent concrete, ceramic, glass, macadam, plastic and in one trial pit (TP101), rare slag pieces.

Hardstanding macadam is present at the surface of the access road in the west of the site. Macadam is also locally present at the surface in the south east of the site where a former road was located. TP110 was excavated in this location and noted the macadam surfacing to be 0.05 m thick.

Grass over sandy gravel of Type 1 was encountered at the surface of five pits (TP111, TP115, TP118, TP119 and TP120) in the vicinity of the former school building, and was encountered to depths of between 0.15 and 0.45 m. Within TP115, gravel of sandstone and brick fragments is also present to a depth of 0.35 m. Type 1 was also encountered below the macadam hardstanding within TP110 to a depth of 0.3 m.

The remnants of an area of burnt ashy ground were observed at the surface around TP106, but did not extend below the surface.

### **6.2 Made Ground**

Ashy made ground with gravel of coal, clinker and glass was encountered within three trial pits in the south east of the site: TP108 from 1.3 to 1.45 m depth, TP109 from 2.5 to 2.8 m depth (0.8 to 1.1 m below the base of the bund) and TP110 from 1.0 to 1.5 m depth. Occasional ashy pockets were also noted below the ashy ground within TP109 between 2.8 and 3.5 m (equivalent to 1.1 and 1.8 m below the base of the bund), whilst made ground of predominantly clinker was also encountered within TP117 from 0.5 to 1.1 m bgl.

The remainder of the made ground encountered below the site is similar in consistency to the topsoil/made ground described above, and extends to depths of between 0.2 and 2.0 m. The gravel content of the made ground is typically higher than the topsoil/made ground and also includes occasional clinker, wood and pot fragments. Cobbles of sandstone, bricks, concrete and macadam are also occasionally present, whilst larger objects including reinforced concrete, old rebar and old concrete beams were encountered within TP107 and TP116 in the north east of the site.

The made ground described above also comprises the earth bund located in the south east of the site, whilst numerous concrete flags and a log fragment were also encountered. TP109 was excavated close to the top of the bund, with the bund material extending to a depth of 1.7 m. Made ground was encountered below this to a depth of 3.55 m from the top of the bund (1.85 m below the expected original ground level).

### **6.3 Natural Ground**

The natural ground generally comprises weathered sandstone which became difficult to excavate within a number of trial pits at depths of between 1.3 and 2.7 m bgl.

Clay tending towards mudstone was encountered within TP115 in the south west of the site at a depth of 1.8 m to at least 2.4 m. A 200 mm thick clay band was also encountered below the made ground in TP121, and 500 mm thick in TP110 from 2 m.

### **6.4 Groundwater**

A slight groundwater ingress was recorded at the base of TP115 at 2.4 m. Damp strata were also encountered from 1.6 m bgl within TP110. No other groundwater ingresses were noted.

## **7.0 GEOTECHNICAL APPRAISAL**

### **7.1 General**

The proposed development is to comprise residential housing of conventional construction with associated soft landscaped areas.

Topsoil/made ground or made ground was encountered below the majority of site to depths of between 0.2 and 2.0 m, and typically no greater than 1.3 m. The natural ground below the site typically comprises weathered sandstone. Clay tending towards mudstone was encountered within one trial pit in the south west of the site at a depth of 1.8 m to at least 2.4 m, whilst thin bands of clay were locally encountered with a thickness of up to 500 mm within a further two trial pits.

A slight groundwater ingress was recorded at the base of TP115 at 2.4 m. Damp strata were also encountered from 1.6 m bgl within TP110. No other groundwater ingresses were noted.

An earth bund up to approximately 2 m in height is present in the south east of the site. It is assumed that this will be regraded prior to any development on the site taking place.

An embankment up to approximately 2 m high is present along much of the western boundary of the site, to the west of the road. According to the most recent development plan, it is proposed to construct houses adjacent to much of the western site boundary, whilst keeping the existing access road. Releveling of this embankment, which mostly comprises weathered sandstone, will therefore be required prior to development, and retaining should be allowed for.

One sample of natural clay was sent for geotechnical testing and recorded a modified plasticity index of 20.9%, equating to medium volume change potential in accordance with NHBC Standards.

### **7.2 Foundations**

Traditional strip or trench fill foundations are considered to be appropriate across the site. Foundations should be taken through the made ground and constructed within the weathered sandstone at a minimum depth of 750 mm. Where greater thicknesses of made ground are present, or where ground levels are raised, traditional trench fill foundations may be required.

Where cohesive ground is found, a minimum depth of 900 mm should be applied from the lower of the finished or existing ground level.

Foundations within clay soils will need to be designed in accordance with the NHBC Standards, Chapter 4.2, where past or present trees are within influencing distance of the foundation. However,

tree influence across the site is expected to be minimal as the natural ground was predominantly granular in nature.

### **7.3 Ground Floors**

Where there is less than 600 mm of made ground below the ground floor, ground bearing slabs are expected to be appropriate. Where more than 600 mm of made ground will be present below the ground floor slab, a reinforced suspended slab or precast concrete floor with a minimum 150 mm high ventilated void should be allowed for.

### **7.4 Superstructure Precautions**

Additional superstructure precautions should not be required based on the ground conditions encountered.

### **7.5 Obstructions and Excavation Problems**

The weathered sandstone encountered below the site became difficult to excavate at depths of between 1.3 and 2.7 m bgl.

The stability of trenches may be poor within sandy soils or within made ground. The made ground within TP107 and TP116 was found to comprise larger objects including reinforced concrete, old rebar and old concrete beams.

Temporary support will be required in accordance with current Health & Safety Regulations wherever access is required to trenches deeper than 1.2 m or less where there is risk of collapse.

### **7.6 Roads**

A CBR value of at least 2% may be appropriate for road design. The ground should be assumed to be frost susceptible and a minimum capping thickness of 450 mm will therefore apply. It is recommended that CBR tests are undertaken along any proposed roads prior to construction so that more accurate CBR values can be obtained.

### **7.7 Surface Water Drainage**

Infiltration tests were carried out within seven trial pits, referenced SA1/TP113, SA2/TP114, SA3/TP115, SA4/TP116, SA5/TP117, SA6/TP118 and SA7/TP121. The calculations of infiltration rates are provided in Appendix 4, and are summarised in the following table:

| Pits               | Average Infiltration Rate<br>( $\times 10^{-6}$ ) m/s | BRE365 Infiltration Rate<br>( $\times 10^{-6}$ ) m/s |
|--------------------|-------------------------------------------------------|------------------------------------------------------|
| SA1/TP113 (Test 1) | 520                                                   | 550                                                  |
| SA1/TP113 (Test 2) | 400                                                   | 420                                                  |
| SA1/TP113 (Test 3) | 290                                                   | 350                                                  |
| SA2/TP114 (Test 1) | 480                                                   | 600                                                  |
| SA2/TP114 (Test 2) | 340                                                   | 420                                                  |
| SA2/TP114 (Test 3) | 350                                                   | 330                                                  |
| SA3/TP115          | 2.7                                                   | -                                                    |
| SA4/TP116 (Test 1) | 140                                                   | 180                                                  |
| SA4/TP116 (Test 2) | 160                                                   | 160                                                  |
| SA5/TP117 (Test 1) | 73                                                    | 77                                                   |
| SA5/TP117 (Test 2) | 100                                                   | 100                                                  |
| SA6/TP118 (Test 1) | 34                                                    | 52                                                   |
| SA6/TP118 (Test 2) | 93                                                    | 86                                                   |
| SA6/TP118 (Test 3) | 99                                                    | 100                                                  |
| SA7/TP121          | 7.1                                                   | -                                                    |

The water drained past the 25% effective depth within each of the tests carried out within SA1/TP113, SA2/TP114, SA4/TP116, SA5/TP117 and SA6/TP118. Two or three tests were undertaken within each of these pits, which took between 5 and 50 minutes to drain.

The water did not drain past the 75% within the remaining two test locations, SA3/TP115 and SA7/TP121, which were located in the south west of the site. Clay tending towards mudstone was encountered at the base of SA3/TP115, as was water from 2.4 m, although clay and sandstone were recorded in SA7/TP121.

It is considered that soakaway drainage could be suitable if the soakaway chambers are installed within the natural weathered sandstone. However, the slower infiltration rates and presence of groundwater at 2.4 m depth recorded in the south west of the site will need to be taken into account during design.

## **8.0 REFINEMENT OF OUTLINE CONCEPTUAL MODEL**

### **8.1 Source Characterisation**

An outline conceptual model, detailing the possible sources and associated contaminants of concern, potential pathways and receptors identified in the Phase 1, is set out in Section 4.

This section of the report documents the works undertaken to obtain information to test and refine this model enabling a risk assessment to be produced and, where significant risks are expected, remediation recommendations.

### **8.2 Ground Gas**

The materials encountered in the intrusive investigation did not contain a significant proportion of organic or degradable materials.

No radon precautions or ground gas protective measures are considered to be required for new dwellings constructed at the site.

### **8.3 Unexpected Contamination**

A slight hydrocarbon odour was noted emanating from TP106 from 0.45 to 0.6 m bgl. Burnt ashy ground was also noted at the surface around the location of TP106.

Fragments of asbestos were noted within the topsoil/made ground within one trial pit (TP121) in the south west corner of the site. Fragments were recorded within the made ground in three trial pits located in the east of the site (TP107 between the surface and 1.2 m depth, TP108 from the surface to 0.5 m depth, and TP116 from the surface to 0.7 m depth).

No signs of visual or olfactory evidence of significant contamination were recorded within any of the remaining exploratory holes across the site.

### **8.4 Chemical Testing**

Four samples of topsoil/made ground, eleven samples of made ground and four samples of natural ground were dispatched for chemical testing. Each of the samples was analysed for the suite of contaminants listed in the table below:

| <b>Contaminant Type</b> | <b>Actual Contaminants</b>                                                                |
|-------------------------|-------------------------------------------------------------------------------------------|
| Metals/Metalloids       | Arsenic, cadmium, chromium (III and VI), lead, mercury, nickel, selenium, copper and zinc |
| PAHs                    | Speciated PAH                                                                             |
| Sulphates*              | pH, water soluble sulphate, acid soluble sulphate and sulphur                             |

\* Made ground and natural ground samples only.

In addition to this, the samples of topsoil and made ground were screened for asbestos.

One sample of made ground (TP106 0.5 m) was tested for TPH CWG and total organic carbon (TOC), whilst another sample of made ground (TP113 0.7 m) was also tested for TOC.

Calorific value tests were also undertaken on two samples of ashy made ground (TP108 1.4 m and TP110 1.3 m).

## 8.5 Assessment Criteria

The proposed development of the site is for residential properties with associated soft landscaping. Tables detailing the relevant assessment concentrations used are included in Appendix 5.

## 8.6 Chemical Test Results

### 8.6.1 Topsoil/Made Ground

Five PAHs significantly exceeded their respective assessment value for human health within one sample of topsoil/made ground (TP101 0.2 m). These elevated concentrations are summarised in the table below.

| PAH                   | Assessment Value<br>1% SOM (mg/kg) | Elevated Concentrations<br>(mg/kg) | Modified Mean<br>(mg/kg) |
|-----------------------|------------------------------------|------------------------------------|--------------------------|
| Benzo[a]anthracene    | 7.2                                | 17                                 | <b>14.4</b>              |
| Chrysene              | 15                                 | 18                                 | <b>15.3</b>              |
| Benzo[b]fluoranthene  | 2.6                                | 20                                 | <b>16.9</b>              |
| Benzo[a]pyrene        | 2.2                                | 21                                 | <b>17.7</b>              |
| Dibenz(a,h)Anthracene | 0.24                               | 2.3                                | <b>1.9</b>               |

All modified means still exceed the assessment values, and the elevated concentrations are identified as statistical outliers.

No other elevated concentrations of contaminants were recorded within any of the samples of topsoil/made ground tested.

A fragments of cement bound asbestos was noted within the topsoil/made ground within TP121. Asbestos (chrysotile) fibres were detected during chemical testing of the sample. A quantification test was carried on the sample and recorded the percentage of fibres to be 0.39%.

## 8.6.2 Made Ground

Two samples of ashy made ground (TP108 at 1.4 m and TP110 at 1.3 m) and one sample comprising predominantly gravel of clinker (TP117 at 0.7 m) were sent for chemical testing. Elevated concentrations of two heavy metals and two PAHs were recorded across these three samples (assuming a worst case scenario of 1% SOM), and are summarised in the table below.

| Determinand          | Assessment Value (mg/kg) | Elevated Concentration (mg/kg) |             |             |
|----------------------|--------------------------|--------------------------------|-------------|-------------|
|                      |                          | TP108 1.4 m                    | TP110 1.3 m | TP117 0.7 m |
| Arsenic              | 37                       | 110                            | 59          | 53          |
| Lead                 | 200                      | 360                            | -           | 230         |
| Benzo[b]fluoranthene | 2.6                      | -                              | -           | 3.6         |
| Benzo[a]pyrene       | 2.2                      | -                              | -           | 3.4         |

Calorific value tests were also completed on two of the samples of ashy made ground. TP108 at 1.4 m recorded a value of 10 MJ/kg and TP110 at 1.3 m recorded a value of 15 MJ/kg, indicating this material to be potentially combustible.

Across the remaining samples of made ground, one sample (TP113 at 0.7 m) recorded elevated concentrations of two metals and four PAHs, including volatile naphthalene, assuming a worst case scenario of 1% SOM. Another two samples (TP107 at 0.3 m and TP108 at 0.3 m) recorded slightly elevated concentrations of two PAHs. Modified means (and a mean value test for lead) have been calculated across the samples of non-ashy made ground. These results are summarised in the table below.

| Determinand           | Assessment Value (mg/kg) |        | Elevated Concentrations (mg/kg) |             |            | Modified/ Corrected Mean (mg/kg) |
|-----------------------|--------------------------|--------|---------------------------------|-------------|------------|----------------------------------|
|                       | 1% SOM                   | 6% SOM | TP107 0.3 m                     | TP108 0.3 m | TP113 0.7m |                                  |
| Arsenic               | 37                       |        | -                               | -           | 110        | 50.2                             |
| Lead                  | 200                      |        | -                               | -           | 510        | 150                              |
| Naphthalene           | 2.3                      | 13     | -                               | -           | 2.4        | 1.01                             |
| Benzo[b]fluoranthene  | 2.6                      | 3.7    | 4.1                             | 3.1         | 6.5        | 3.74                             |
| Benzo[a]pyrene        | 2.2                      | 3.0    | 4.7                             | 3.2         | 6.9        | 3.98                             |
| Dibenz(a,h)anthracene | 0.24                     | 0.3    | -                               | -           | 0.27       | 0.16                             |

Sample TP113 at 0.7 m was subsequently tested for total organic carbon, which recorded 14% (equivalent to 24% SOM). Assessment criteria derived using 6% SOM are therefore considered appropriate for this sample. The assessment value for naphthalene increases to 13 mg/kg, and dibenz(a,h)anthracene to 0.3 mg/kg, both of which are higher than the recorded concentrations within the TP113 sample. The other contaminants remain slightly elevated compared to their respective assessment values.

Arsenic, benzo[b]fluoranthene and benzo[a]pyrene modified means remain elevated with respect to their assessment values for human health, and the elevated arsenic, naphthalene and dibenz(a,h)anthracene concentrations recorded within TP113 at 0.7 m depth are probable outliers.

Five metals also exceeded their respective phytotoxicity limits for plant growth within TP113 at 0.7 m, including copper, nickel and zinc in addition to arsenic and lead.

No elevated hydrocarbon fractions were recorded within sample TP106 at 0.5 m depth, where a slight hydrocarbon odour was noted during the investigation.

No asbestos fibres were detected within any of the samples of made ground. However, visible fragments of asbestos were noted within the made ground in TP107, TP108 and TP116.

### **8.6.3 Natural Ground**

No elevated concentrations of contaminants were recorded within any of the samples of natural ground tested.

### **8.6.4 Sulphates**

The site has been taken as a Brownfield location in relation to the Aggressive Chemical Environment for concrete classifications and groundwater is assumed to be mobile.

The samples of ashy made ground recorded a maximum total potential sulphate concentration of 1.23% and water soluble concentration of 410 mg/l. The samples recorded a pH of between 5.6 and 7.5.

Across the remaining samples of made ground, a maximum total potential sulphate concentration of 0.81% and water soluble concentration of 65 mg/l. The samples recorded a pH of between 6 and 8.2. Characteristic values have been calculated: the maximum total potential sulphate concentration decreases to 0.5%, the maximum water soluble concentration decreases to 50 mg/l, and pH increases to 6.7.

The samples of natural ground recorded a maximum total potential sulphate concentration of 0.051% and water soluble concentration of 42 mg/l. The samples recorded a pH of between 6.3 and 7.6.

## 8.7 Significant Pollutant Linkages

The significant pollutant linkages identified are documented in the table below:

| Source                             | Contaminant                                            | Pathway                                   | Receptor                                                                                                                      |
|------------------------------------|--------------------------------------------------------|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Topsoil/Made Ground<br>Made Ground | Metals/metalloids<br>PAHs<br>Asbestos fragments/fibres | Ingestion<br>Inhalation<br>Direct contact | Future residents and visitors to the site<br>Site construction workers<br>Plants<br>Secondary A Aquifer<br>Water Supply Pipes |
| Made Ground                        | Sulphates                                              | Direct contact                            | Subsurface concrete                                                                                                           |
| Made and natural ground            | Low pH                                                 |                                           |                                                                                                                               |

## **9.0 RISK ASSESSMENT**

### **9.1 Human Health: Future Site Users**

#### **Topsoil/Made Ground**

One sample of topsoil/made ground (TP101 0.2 m) recorded significantly elevated concentrations of five PAHs, which were considered statistical outliers. Asbestos (chrysotile) fragments/fibres were identified within TP121, located in the south west of the site.

Previous investigations recorded slightly elevated arsenic, lead, benzo(b)fluoranthene and benzo(a)pyrene, however none of the modified or corrected means exceeded the assessment values.

Any visible fragments of asbestos containing material should be removed by a specialist contractor. After removal of visible ACM, it is recommended that the topsoil/made ground around TP121 is tested further to confirm its suitability.

Due to the extraneous material content, the remaining topsoil may also require screening but should be suitable for re-use, subject to regulatory approval.

#### **Made Ground**

The ashy made ground found below the south east of the site recorded elevated concentrations of metals and PAHs. This is in line with the concentrations recorded in previous investigations. This ashy ground also recorded calorific values of 10 and 15 MJ/kg in this investigation, indicating the material is potentially combustible.

Across the remaining samples of made ground, elevated metals and PAHs were recorded within three samples, with the more elevated concentrations noted in TP113 where the made ground contained a high proportion of rubble including bricks, concrete, ceramic, scrap metal, glass, clinker, wood and slate.

Only slightly elevated PAH concentrations were recorded in TP107 and TP108, although possible asbestos sheet fragments were noted in TP107, TP108 and TP116. No asbestos fibres were however recorded.

Due to the potential for encountering asbestos containing material and a high proportion of rubble in the made ground, where made ground is to remain below gardens a minimum 600 mm thick capping layer (including at least 100 mm clean topsoil) will be required overlying a geotextile marker layer. The capping layer will need to be increased to 1 m thick where ashy made ground is present due to the potential for combustion.

As noted above, any visible fragments of asbestos containing material should be removed by a specialist contractor.

## **9.2 Human Health: Construction Workers**

Groundworkers employed during the construction phase of the development are most at risk of harm due to them having direct contact with affected soils. However, the contact is generally of short duration, and all competent groundworkers will be aware of the potential risks associated with handling soils. Therefore the overall risk to the health of construction workers is considered to be extremely low.

All ground workers employed on the site should be made aware that elevated concentrations of metals and PAHs may be present within the soils below the site, and that asbestos fibres may also be present. Normal site procedures such as the wearing of gloves when handling soils, and the washing of hands prior to eating should be implemented.

Any unusual, brightly coloured, ashy or odorous material or material suspected of containing asbestos encountered during construction should be brought to the attention of the site staff and investigated.

## **9.3 Construction Materials**

Based on the results recorded, DS-3 AC-4 sulphate precautions are considered to be required for sub-surface concrete in contact with the ashy made ground.

For sub-surface concrete in contact with the made ground across the remainder of the site, DS-2 AC-2 sulphate precautions are considered to be required.

DS-1 AC-2z sulphate precautions are required for sub-surface concrete in contact with the natural ground only.

The chemical test results will need to be submitted to the water supplier for review so that appropriate water supply pipes can be selected.

## **9.4 Ground Gas**

No radon or ground gas precautions are required for the site.

## **9.5 Plants**

Two metals (copper and zinc) exceeded their respective phytotoxicity limits for plant growth within one sample of the ashy made ground (TP110 at 1.3 m).

As discussed above, a 600 mm thick capping layer, including at least 100 mm topsoil, is considered to be required for gardens and landscaped areas overlying topsoil/made ground or made ground, increasing to 1 m thick where ashy made ground is present. This is considered to provide a suitable growing medium for plants.

Where natural weathered sandstone is to directly underlie gardens, a minimum 100 mm of topsoil will need to be provided.

## **9.6 Controlled Waters**

Elevated levels of metals/metalloids and PAHs were recorded within the made ground below the site. However, no evidence of migrating contamination was observed below the site, as no elevated concentrations of contaminants were recorded within the weathered sandstone.

The site overlies a Secondary A Aquifer and the nearest surface water feature is located approximately 470 m from the site. The risk to controlled waters is therefore considered to be negligible. However, standard good site practice during the construction works must still be adhered to in order to ensure that there is no risk to controlled waters.

## **9.7 Disposal of Material**

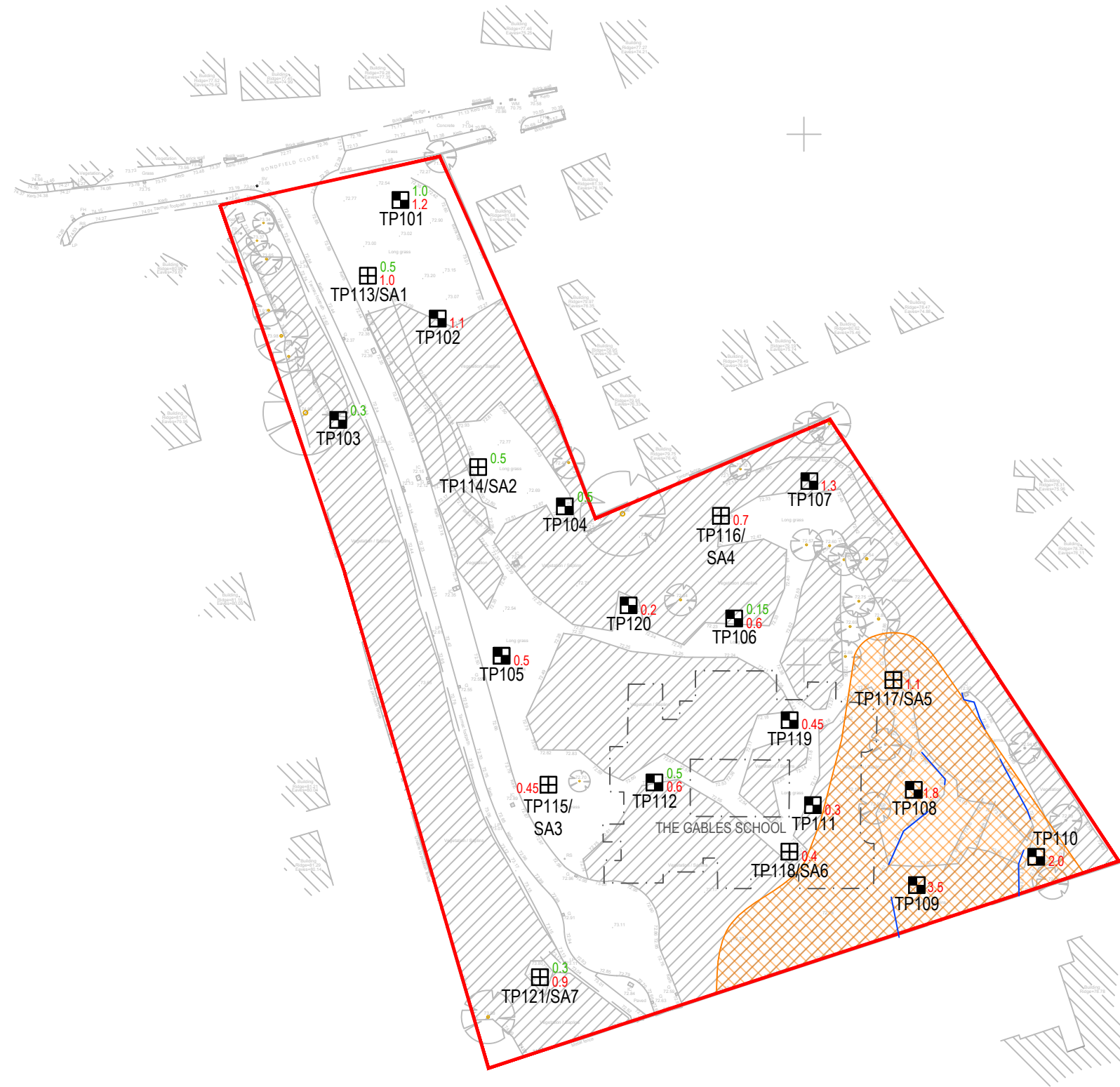
If material needs to be removed, it should to be taken to a suitably licensed landfill or waste treatment facility. The costs of disposal and landfill tax can be substantial. The disposal of material should therefore be seen as a last resort with options such as treatment and reuse either on-site or off-site considered where possible.

The category of landfill which can accept the waste (inert, non-hazardous or hazardous) would need to be determined and will also have a significant effect on the costs. Additional testing may be required by the landfill operator and the acceptance of material is generally at their discretion.

Any macadam surfacing may contain coal tar and this should be tested at an early stage to ensure that it can be dealt with.

## **Appendix 1**

‘Exploratory Hole Location Plan’, Drawing Number 42937/001



INFORMATION WITHIN THIS DRAWING IS NOT NECESSARILY PRODUCED TO SCALE.  
ALWAYS USE FIGURED DIMENSIONS AND CO-ORDINATES - IF IN DOUBT, ASK.

**Key:**

-  Approximate location of trial pit excavated by Eastwood & Partners on 22-23.08.18.
-  Approximate location of soakaway carried out by Eastwood & Partners on 23.08.18.
-  Approximate location of former building.
-  Site Boundary.
-  Approximate location of bund.
-  Depth to base of topsoil/ made ground. (m)
-  Depth to base of made ground. (m)
-  Approximate extent of shallow "ashy made ground"

|     |              |     |     |      |
|-----|--------------|-----|-----|------|
| A   | First Issue. |     |     |      |
| REV | DESCRIPTION  | SIG | CHK | DATE |

STRATEGIC TEAM GROUP

BONDFIELD COURT, WOMBWELL

EXPLORATORY HOLE LOCATION  
PLAN

**Eastwood & Partners** **EOP**  
CONSULTING ENGINEERS  
St. Andrew's House  
23 Kingfield Road  
Sheffield S11 9AS  
Tel 0114 255 4554  
Fax 0114 255 4330  
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www.eastwoodandpartners.com

| SCALE WHEN PLOTTED AT A3<br>1:1000 |               |                  | DRAWING STATUS<br>INFORMATION |          |
|------------------------------------|---------------|------------------|-------------------------------|----------|
| DRAWN<br>TC                        | CHECKED<br>DN | DATE<br>04.09.18 | DRAWING NUMBER<br>42937/001   | REV<br>A |

## **Appendix 2**

Envirocheck

Consultants Coal Mining Report

# Historical Mapping Legends

## Ordnance Survey County Series 1:10,560

|  |                                               |  |                             |  |               |
|--|-----------------------------------------------|--|-----------------------------|--|---------------|
|  | Gravel Pit                                    |  | Sand Pit                    |  | Other Pits    |
|  | Quarry                                        |  | Shingle                     |  | Orchard       |
|  | Osiers                                        |  | Reeds                       |  | Marsh         |
|  | Mixed Wood                                    |  | Deciduous                   |  | Brushwood     |
|  | Fir                                           |  | Furze                       |  | Rough Pasture |
|  | Arrow denotes flow of water                   |  | Trigonometrical Station     |  |               |
|  | Site of Antiquities                           |  | Bench Mark                  |  |               |
|  | Pump, Guide Post, Signal Post                 |  | Well, Spring, Boundary Post |  |               |
|  | •285 Surface Level                            |  |                             |  |               |
|  | Sketched Contour                              |  | Instrumental Contour        |  |               |
|  | Main Roads                                    |  | Minor Roads                 |  |               |
|  | Sunken Road                                   |  | Raised Road                 |  |               |
|  | Road over Railway                             |  | Railway over River          |  |               |
|  | Railway over Road                             |  | Level Crossing              |  |               |
|  | Road over River or Canal                      |  | Road over Stream            |  |               |
|  | Road over Stream                              |  |                             |  |               |
|  | County Boundary (Geographical)                |  |                             |  |               |
|  | County & Civil Parish Boundary                |  |                             |  |               |
|  | Administrative County & Civil Parish Boundary |  |                             |  |               |
|  | County Borough Boundary (England)             |  |                             |  |               |
|  | County Burgh Boundary (Scotland)              |  |                             |  |               |
|  | Rural District Boundary                       |  |                             |  |               |
|  | Civil Parish Boundary                         |  |                             |  |               |

## Ordnance Survey Plan 1:10,000

|  |                                                                       |  |                                                         |
|--|-----------------------------------------------------------------------|--|---------------------------------------------------------|
|  | Chalk Pit, Clay Pit or Quarry                                         |  | Gravel Pit                                              |
|  | Sand Pit                                                              |  | Disused Pit or Quarry                                   |
|  | Refuse or Slag Heap                                                   |  | Lake, Loch or Pond                                      |
|  | Dunes                                                                 |  | Boulders                                                |
|  | Coniferous Trees                                                      |  | Non-Coniferous Trees                                    |
|  | Orchard                                                               |  | Scrub                                                   |
|  | Bracken                                                               |  | Heath                                                   |
|  | Marsh                                                                 |  | Reeds                                                   |
|  | Building                                                              |  | Glasshouse                                              |
|  | Sloping Masonry                                                       |  | Pylon                                                   |
|  | Cutting                                                               |  | Embankment                                              |
|  | Road Under                                                            |  | Road Over                                               |
|  | Level Crossing                                                        |  | Foot Bridge                                             |
|  | Standard Gauge Multiple Track                                         |  | Standard Gauge Single Track                             |
|  | Siding, Tramway or Mineral Line                                       |  | Narrow Gauge                                            |
|  | Geographical County                                                   |  | Administrative County, County Borough or County of City |
|  | Municipal Borough, Urban or Rural District, Burgh or District Council |  | Borough, Burgh or County Constituency                   |
|  | Civil Parish                                                          |  |                                                         |
|  | BP, BS Boundary Post or Stone                                         |  | Police Station                                          |
|  | Church                                                                |  | Post Office                                             |
|  | Club House                                                            |  | Public Convenience                                      |
|  | Fire Engine Station                                                   |  | Public House                                            |
|  | Foot Bridge                                                           |  | Signal Box                                              |
|  | Fountain                                                              |  | Spring                                                  |
|  | Guide Post                                                            |  | Telephone Call Box                                      |
|  | Mile Post                                                             |  | Telephone Call Post                                     |
|  | Mile Stone                                                            |  | Well                                                    |

## 1:10,000 Raster Mapping

|  |                                                          |  |                                            |
|--|----------------------------------------------------------|--|--------------------------------------------|
|  | Gravel Pit                                               |  | Refuse tip or slag heap                    |
|  | Rock                                                     |  | Rock (scattered)                           |
|  | Boulders                                                 |  | Boulders (scattered)                       |
|  | Shingle                                                  |  | Mud                                        |
|  | Sand                                                     |  | Sand Pit                                   |
|  | Slopes                                                   |  | Top of cliff                               |
|  | General detail                                           |  | Underground detail                         |
|  | Overhead detail                                          |  | Narrow gauge railway                       |
|  | Multi-track railway                                      |  | Single track railway                       |
|  | County boundary (England only)                           |  | Civil, parish or community boundary        |
|  | District, Unitary, Metropolitan, London Borough boundary |  | Constituency boundary                      |
|  | Area of wooded vegetation                                |  | Non-coniferous trees                       |
|  | Non-coniferous trees (scattered)                         |  | Coniferous trees                           |
|  | Coniferous trees (scattered)                             |  | Positioned tree                            |
|  | Orchard                                                  |  | Coppice or Osiers                          |
|  | Rough Grassland                                          |  | Heath                                      |
|  | Scrub                                                    |  | Marsh, Salt Marsh or Reeds                 |
|  | Water feature                                            |  | Flow arrows                                |
|  | Mean high water (springs)                                |  | Mean low water (springs)                   |
|  | Telephone line (where shown)                             |  | Electricity transmission line (with poles) |
|  | Bench mark (where shown)                                 |  | Triangulation station                      |
|  | Point feature (e.g. Guide Post or Mile Stone)            |  | Pylon, flare stack or lighting tower       |
|  | Site of (antiquity)                                      |  | Glasshouse                                 |
|  | General Building                                         |  | Important Building                         |

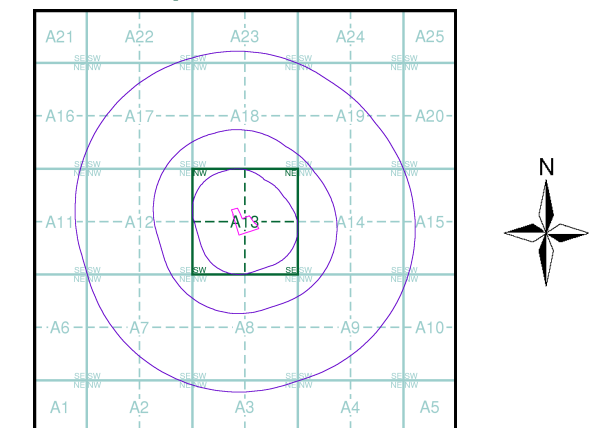
# Envirocheck®

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## Historical Mapping & Photography included:

| Mapping Type         | Scale    | Date        | Pg |
|----------------------|----------|-------------|----|
| Yorkshire            | 1:10,560 | 1854 - 1855 | 2  |
| Yorkshire            | 1:10,560 | 1893        | 3  |
| Yorkshire            | 1:10,560 | 1894        | 4  |
| Yorkshire            | 1:10,560 | 1905 - 1907 | 5  |
| Yorkshire            | 1:10,560 | 1931        | 6  |
| Yorkshire            | 1:10,560 | 1938        | 7  |
| Yorkshire            | 1:10,560 | 1938 - 1948 | 8  |
| Yorkshire            | 1:10,560 | 1948        | 9  |
| Ordnance Survey Plan | 1:10,000 | 1956        | 10 |
| Ordnance Survey Plan | 1:10,000 | 1966 - 1967 | 11 |
| Ordnance Survey Plan | 1:10,000 | 1980        | 12 |
| Ordnance Survey Plan | 1:10,000 | 1989        | 13 |
| 10K Raster Mapping   | 1:10,000 | 2000        | 14 |
| 10K Raster Mapping   | 1:10,000 | 2006        | 15 |
| VectorMap Local      | 1:10,000 | 2018        | 16 |

## Historical Map - Slice A



## Order Details

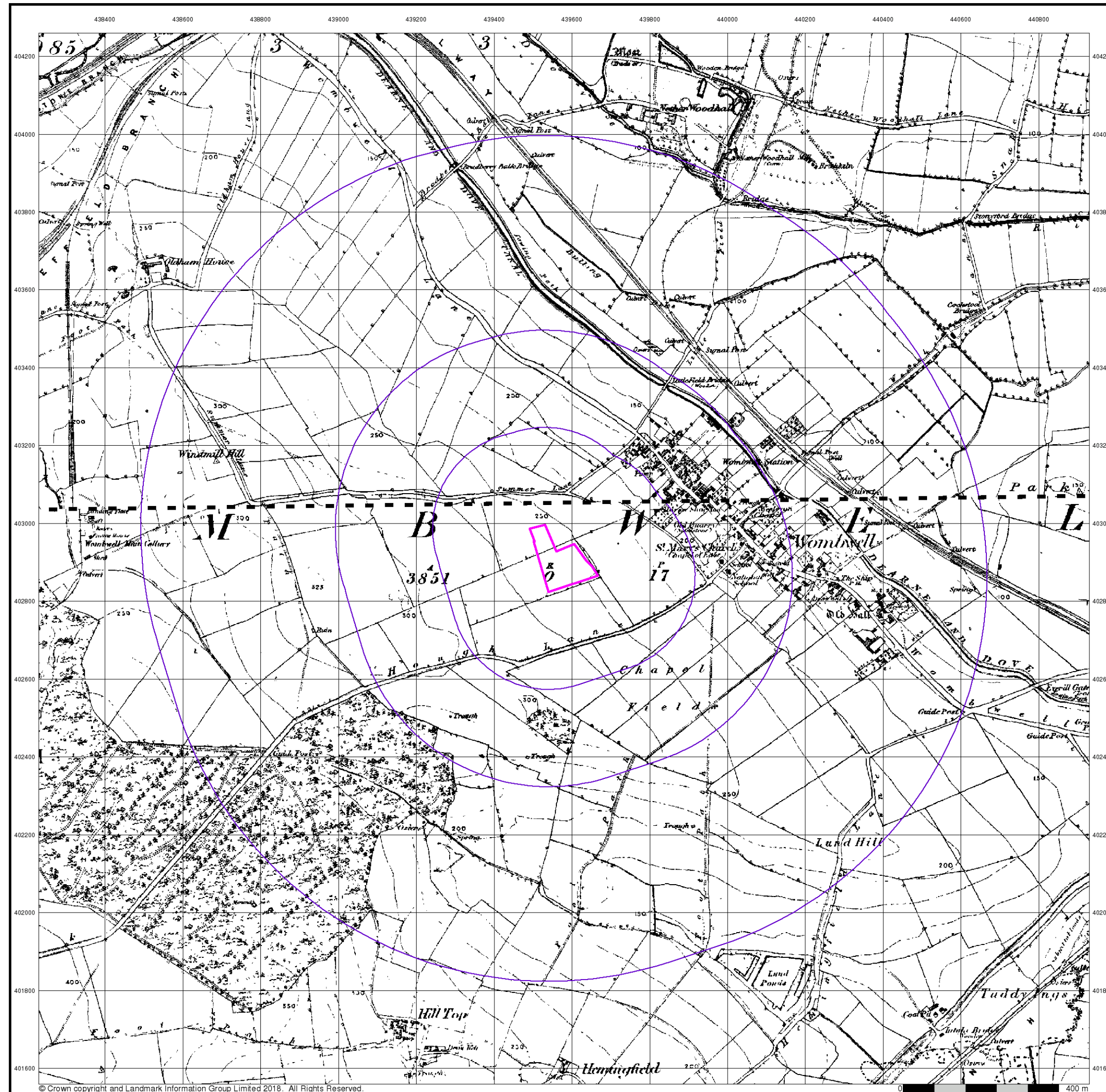
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Customer Ref: 42937  
National Grid Reference: 439570, 402910  
Slice: A  
Site Area (Ha): 1.43  
Search Buffer (m): 1000

## Site Details

Site at 439570, 402910

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Tel: 0844 844 9952  
Fax: 0844 844 9951  
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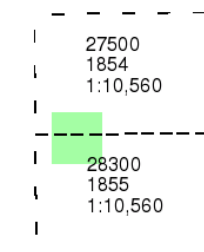
## Yorkshire

Published 1854 - 1855

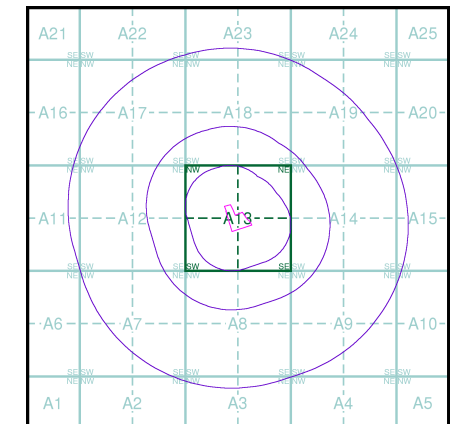
**Source map scale - 1:10,560**

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940's, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

**Map Name(s) and Date(s)**



## Historical Map - Slice A



## Order Details

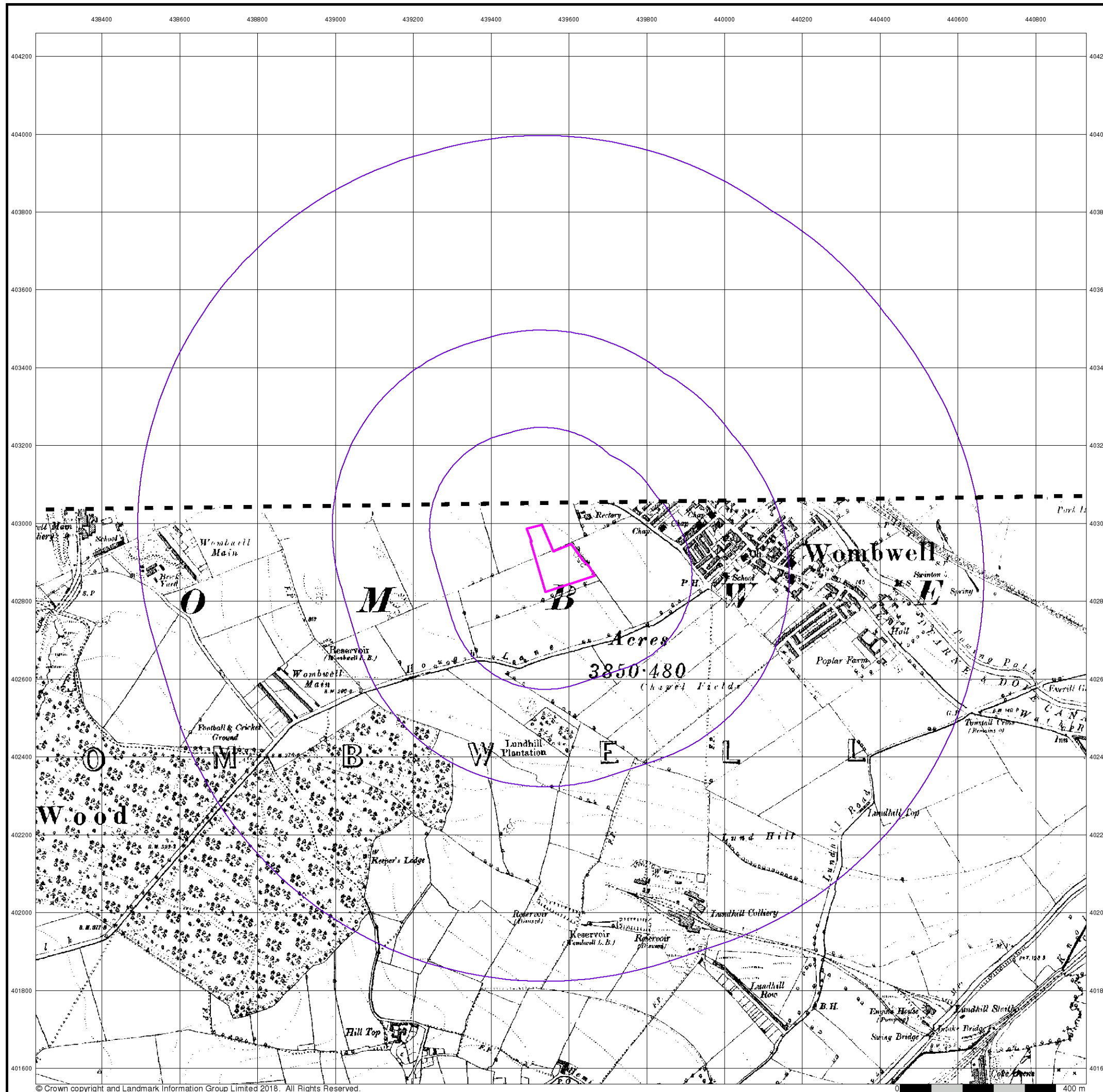
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Customer Ref: 42937  
National Grid Reference: 439570, 402910  
Slice: A  
Site Area (Ha): 1.43  
Search Buffer (m): 1000

## Site Details

Site at 439570, 402910

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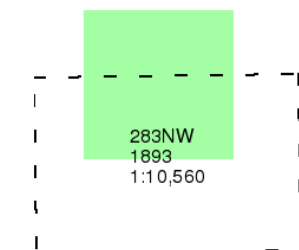
## Yorkshire

**Published 1893**

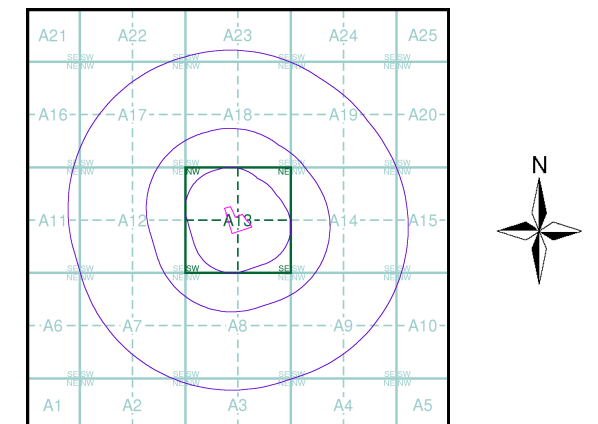
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The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940's, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

## Map Name(s) and Date(s)



### Historical Map - Slice A



## Order Details

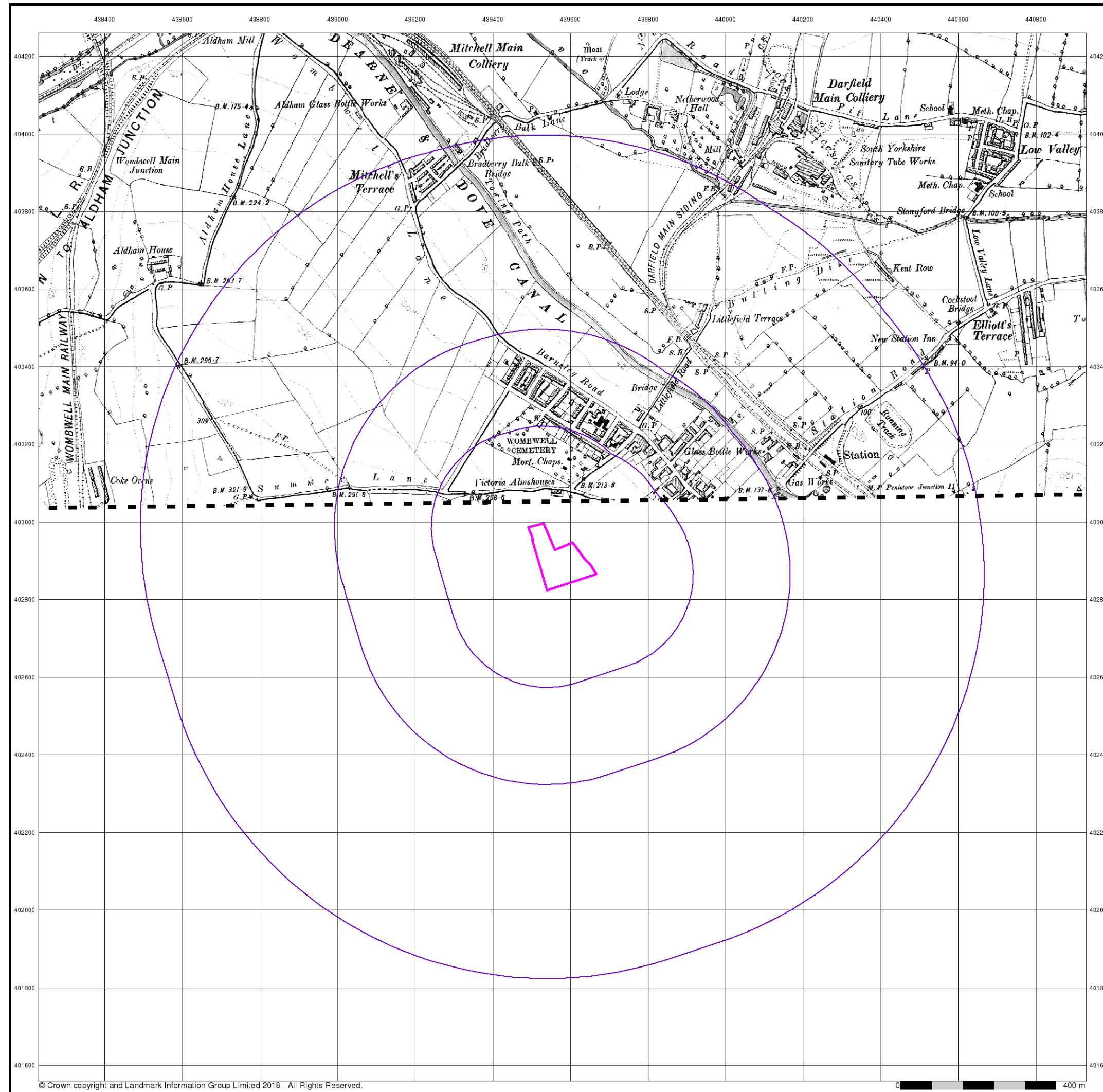
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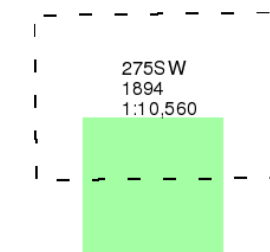
Yorkshire

Published 1894

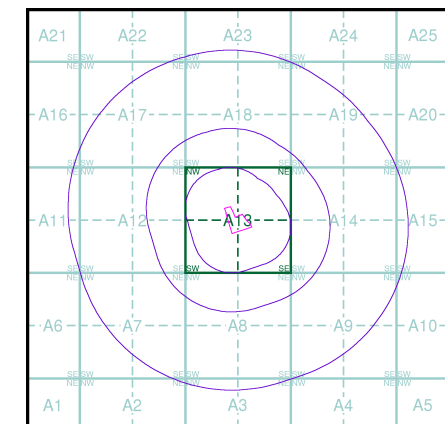
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Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

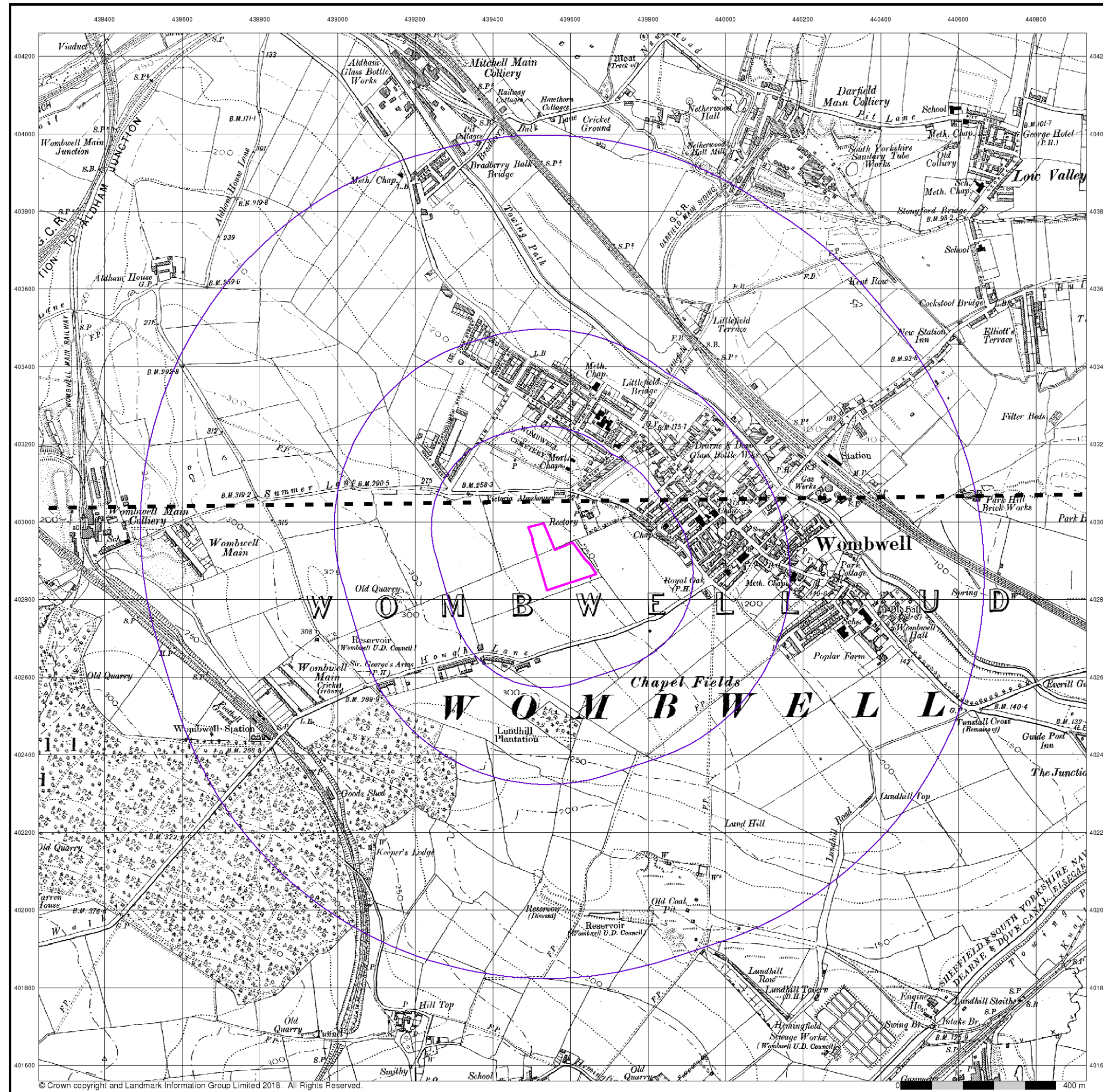
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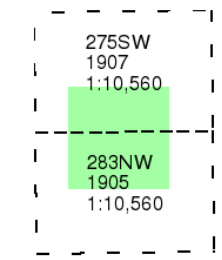
## Yorkshire

Published 1905 - 1907

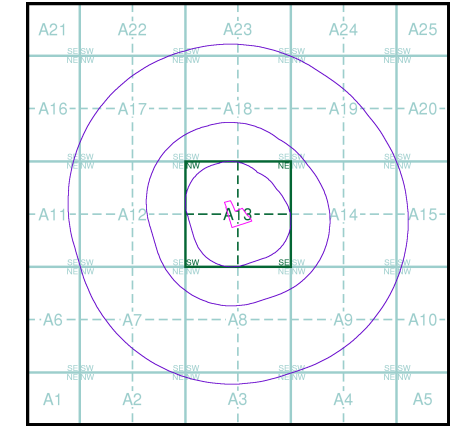
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### Map Name(s) and Date(s)



### Historical Map - Slice A



### Order Details

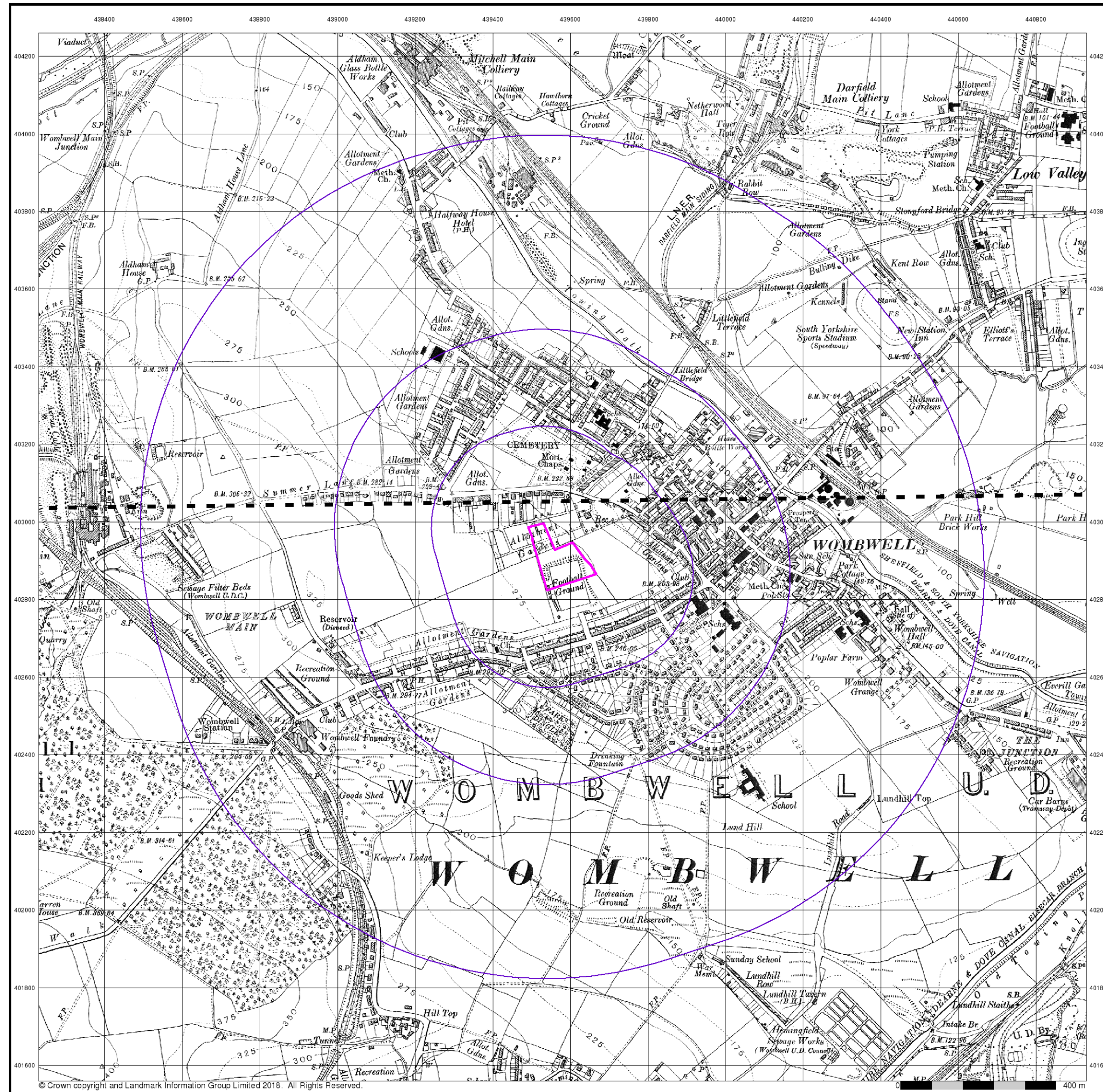
Order Number: 176280669\_1\_1  
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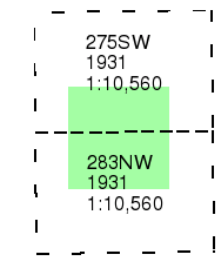
## Yorkshire

Published 1931

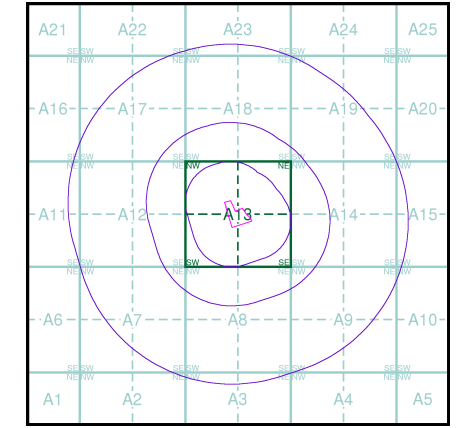
Source map scale - 1:10,560

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